

COMPARATIVE DESCRIPTIONS OF THE FINAL LARVAL  
INSTAR OF *BRUCHUS BRACHIALIS*, *B. RUFIMANUS*,  
AND *B. PISORUM* (COLEOPTERA: BRUCHIDAE)

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ABSTRACT

The final larval instars of *Bruchus brachialis* Fahraeus, *B. pisorum* (Linnaeus), and *B. rufimanus* Boheman are described and compared. Characters used are those of the antennae, clypeolabrum, epipharynx, mandibles, maxillae, labium, legs, spiracles, and anal sulcus.

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Bruchids are a group of seed beetles which infest primarily the seeds of leguminous plants (Johnson 1970). Of those plants attacked by bruchid larvae only a small percentage are of economic importance. Bruchids appear equally successful in parasitizing seeds in the field (Randolph and Gillespie 1958) or in storage (Howe and Currie 1964). In stored seeds, emerging females copulate and begin ovipositing one to several eggs on accessible seeds or pods, whereas in the field the overwintering adults fly to the fields where they initiate a new life cycle (Brindley and Chamberlin 1952). The eggs of these beetles are laid on the pod or seed surface and the emerging larva burrows into the underlying seed and subsequently devours the endosperm of one or more adjacent seeds.

These three species are of considerable economic concern. For example, all varieties of vetch are subject to attack by *B. brachialis*. However, the purple, wooly podded, and smooth or hairy vetches are so heavily parasitized that as many as 90% of the seeds have been destroyed in certain vetch growing regions. The adult female exhibits no preference for seeds in the field or in storage but is capable of infesting both. The contents of each vetch seed is sufficient to rear two or more developing larvae. The adults of *B. brachialis* are host specific as are the adults of *B. pisorum*. The effects of the latter species are, however, more frequently witnessed on green peas in the field rather than dry ones in storage. This fact appears not to have deterred its success however, for in pea growing regions of the northwestern U.S. losses due to *B. pisorum* have exceeded 70%. Of the three species discussed this species is unique in that rarely will there be more than one larva reared per seed (Campbell 1920).

*B. rufimanus* appears to differ biologically from the other two species, since it fails to exhibit host specificity for the broad bean and will readily infest the seeds of peas as well as vetch. In addition, as many as 16 larvae have been recovered from a single seed but normally two to three larvae mature per seed (Campbell 1920). Their ravage has also been extensive, for in certain areas of California as many as 65% of the broad beans have been destroyed.

The purpose of this paper is to provide the first comprehensive comparative descriptions of the final larval instar of the vetch bruchid (*B. brachialis*), the broad bean weevil (*B. rufimanus*), and the pea weevil (*B. pisorum*). A more descriptive account of the biology of these species may be found in Bridwell and Bottimer (1933) or Randolph and Gillespie (1958) for *B. brachialis*, in Brindley and Chamberlin (1952) for *B. pisorum*, and in Campbell (1920) for *B. rufimanus*.

I wish to thank J. M. Kingsolver, U.S. Department of Agriculture, for providing the larvae and C. D. Johnson for his invaluable editorial assistance.

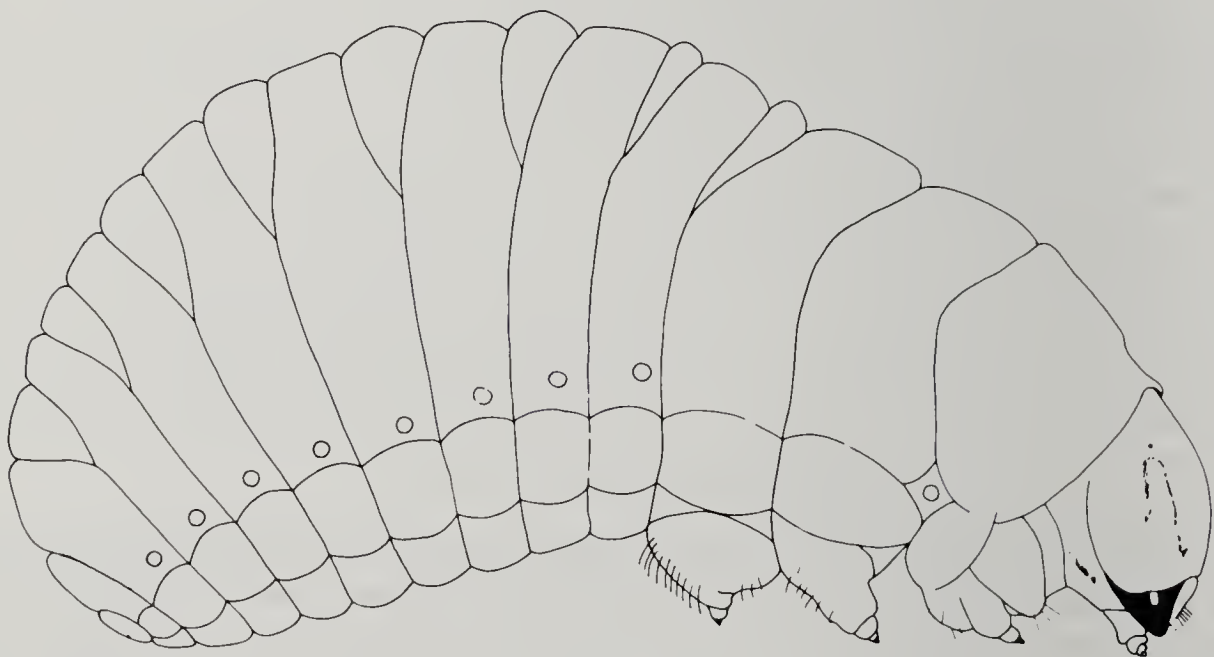
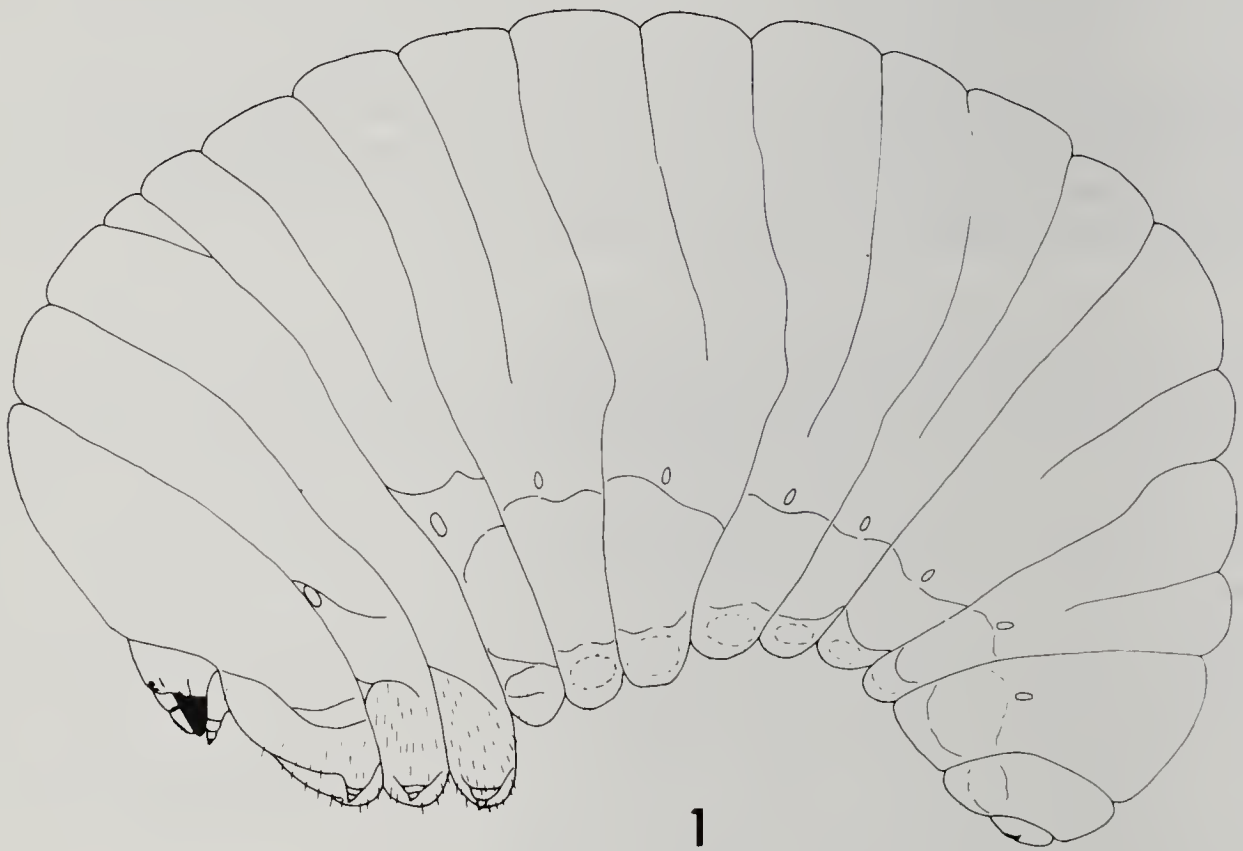


Fig. 1, Larva, common lateral appearance of the three species. Fig. 2, Larva, occasional lateral appearance of *B. pisorum* and *B. rufimanus*.

*Bruchus brachialis* Fahraeus

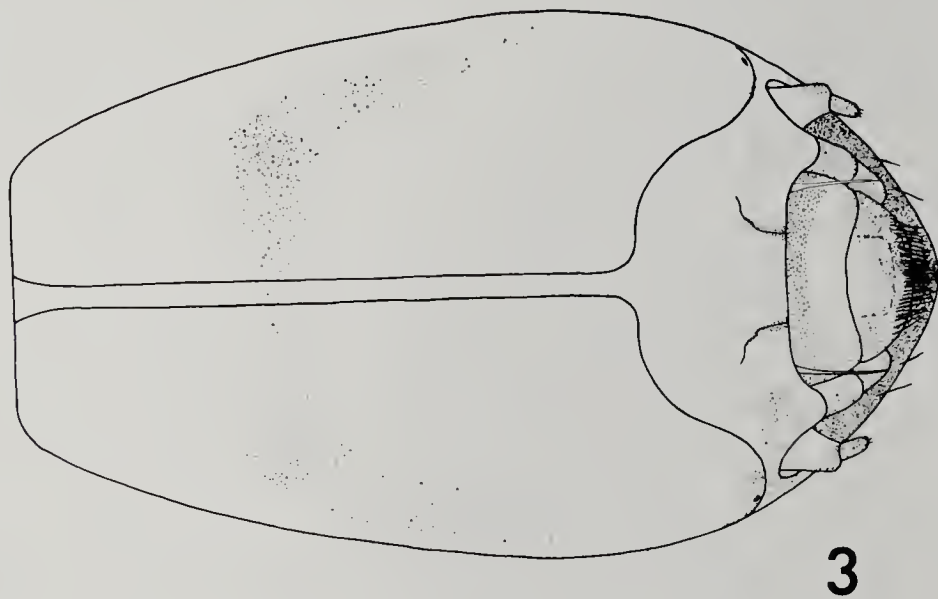
Characteristics of the final instar. *Body*: (Fig. 1) length 3.0-5.0 mm, C-shaped, robust, 1st thru 5th abdominal segments subequal, segments 6-10 strongly tapered posteriorly. Thoracic segments increasing in diameter posteriorly, metathoracic segment exceeding in diameter 1st abdominal segment. Cuticle white or yellowish, without sclerotization, setae restricted primarily to sternopleural regions, setae longest on thoracic sternites, tergal setae sparse, restricted to plical crests of larger abdominal segments. *Head*: (figs. 3, 4) retracted, oval, dorso-ventrally flattened, ventral surface (Fig. 4) occupied mostly by occipital foramen, light tan coloration, pigmentation concentrated near mouthparts. One ocellus located near base of each antenna, situated along anterior arms of lyre-shaped epicranial suture, with or without pigment. *Antenna*: (Fig. 5) located near base of mandible (Figs. 1, 3), 2-segmented; basal segment rectangular, 1/4 as long as distal segment, bearing sensory pore; distal segment quadrate, narrower to subequal in width with basal segment, each sensillum half the length of distal segment, sensilla subtended by 2 minute sensory papillae and 2 sensory setae. Large conspicuous seta located distally on terminal segment, setal length subequal to distal antennal segment. Sclerotized portion of terminal segment extended distally as sharp points. Projections sparse, arranged semi-circularly. *Clypeolabrum*: (Fig. 7) lightly pigmented, clypeal portion quadrate with concave anterior border, bearing 2 latero-medial setae, heavily pigmented, elongate oval area centrally located along clypeolabral border. Pigmented area bears pair of medially located sensory pores, sensory pores and setae located on labral side of clypeolabral suture. Margins of labral sclerite biconvex. Labrum with 3 equidistantly spaced setae arranged in arc situated midway between setal arc and antero-lateral aspects of clypeolabral edge covered by dense setiferous mat. *Epipharynx*: (Fig. 6) biconvex, incomplete transverse sutures, 2 pair of opposed, strongly decurved setae located near distal end of shallow longitudinal depression. Dense rectangular mats of pointed asperities arranged obliquely on opposite sides of median depression. Four elongate blunt setae located in disto-medial arc, dense mat of subequal length setae extend distally to anterior border of epipharynx. *Mandible*: (Fig. 8) prognathous, monocondylic, cutting surface concave, smooth molar surface. *Maxilla*: (Fig. 9) with crescent-shaped cardo; stipes with quadrate base, bearing 11 setae on membranous region; palpifer with 2 setae embedded in sclerite, 1 mid-ventral, 1 anteromedial, small seta near latero-ventral edge of palpus; single segmented palpus, with 1 significantly larger than others; mala bearing 4 antero-medial peg-shaped setae. *Labium*: (Fig. 10) vestiges of submentum represented by median bar-shaped sclerite and lateral circular sclerites. Median sclerite bears 2 lateral short, stout setae, each spheroid sclerite supports 1 medially curved seta; mentum ovoid, flanked proximally by 2 setae, 2 setae in body of mentum each isolated in separate membranous pocket, fused glossae supporting 2 distal decurved setae each with sensory pore near base. *Legs*: (Fig. 11) distance between legs increasing with each succeeding segment, directed antero-medially, 4 segmented with 1 seta located distally on 3rd segment, segments tapering distally, terminating in small lobe-like distal segment. *Spiracles*: (Fig. 12) oval, mesothoracic and 1st abdominal pairs twice as large as remaining pairs, atrium with sclerotized projections appearing singly or in clusters of 2-3, projections few in number. Anus transverse, terminal.

*Material Examined*: 3 final instar larvae, Azores, 11-XI-62, from seeds of *Vicia* sp., collector unknown. Specimens provided by U.S. National Museum, Agricultural Research Division. Determined by association with reared adults.

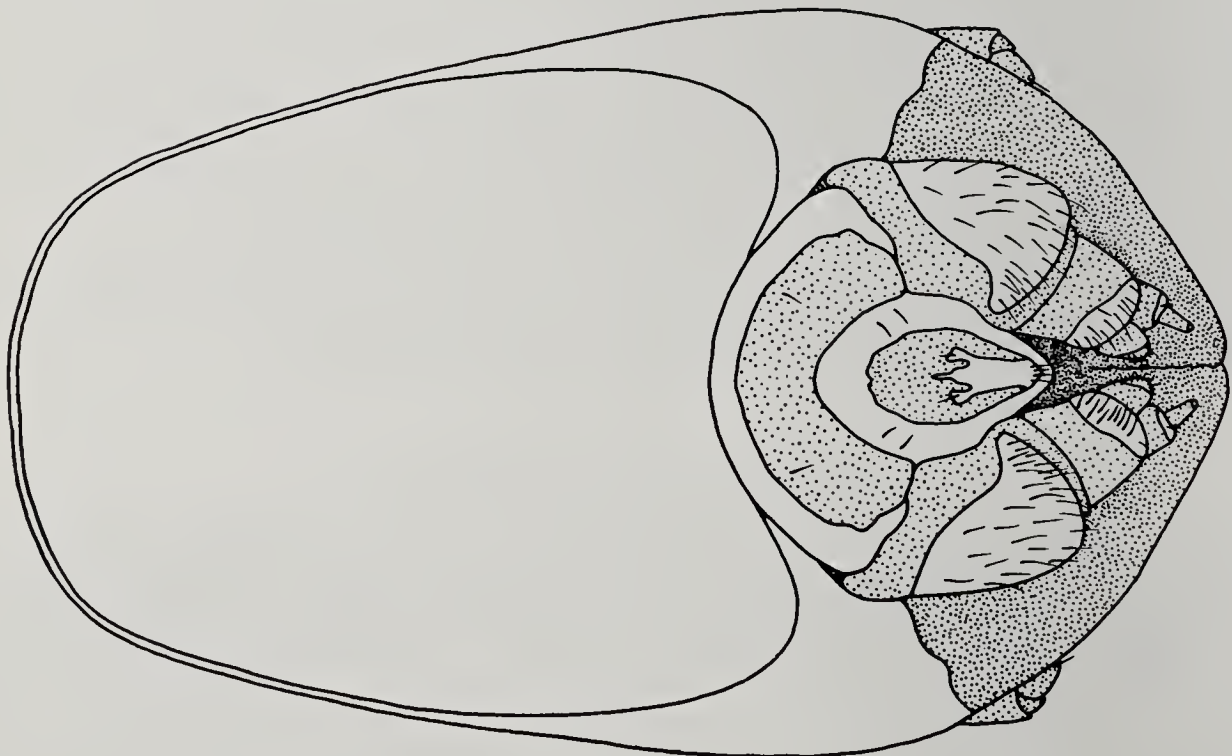
*Bruchus pisorum* (Linnaeus)

Characteristics of the final larval instar. *Body*: (Fig. 1) length 2.5-5.0 mm, C-shaped, robust, subcylindrical, each succeeding thoracic segment of greater diameter, 1st thru 3rd abdominal segments subequal in diameter with increasing length posteriorly, 4th thru 6th abdominal segments nearly subequal with slight posterior taper, very pronounced taper exists with segments 7 thru 10, 10th segment button-like nearly concealed by segment 9. (An alternate body form was observed in a single specimen as seen in Fig. 2. The compactness of the protergites and other unusual contortions indicate this form may have been due to crowding during preservation.) Cuticle white to yellowish, without sclerotization, 2 vaguely yellowish pigmented areas on antero-dorsal aspects of prothorax. Setae nearly inconspicuous, restricted

primarily to sterno-pleural regions, longest on thoracic sternites, sparse on all tergites restricted mostly to plical crests of larger abdominal segments. *Head*: (Figs. 3, 4) retracted (Fig. 1), oval, dorso-ventrally flattened, ventral surface (Fig. 4) occupied mostly by occipital foramen, light tan coloration, pigmentation concentrated near mouthparts primarily on mandibles. One ocellus located near base of each antenna, located along anterior arms of lyre-shaped epicranial suture, with or without pigment. *Antenna*: (Fig. 13) located at base of mandible (Figs. 1, 3), 2 segmented; basal segment transversely rectangular, of subequal width to distal segment, about  $1/3$  as long as distal segment; distal segment longitudinally rectangular, distal end occupied by single sensilla basiconicum and sensory seta, both of equivalent lengths, both slightly longer than basal segment, distal end of apical segment fringed with single row of narrow sclerotized projections, all of subequal length and  $1/2$  as long as sensillum which they surround. *Clypeolabrum*: (fig. 14) lightly pigmented, clypeal portion nearly rectangular in shape, proximal portion bordered by crescent-shaped pigmented area, lateral portions of pigmented area with 1 seta;



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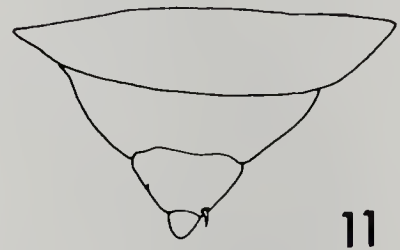
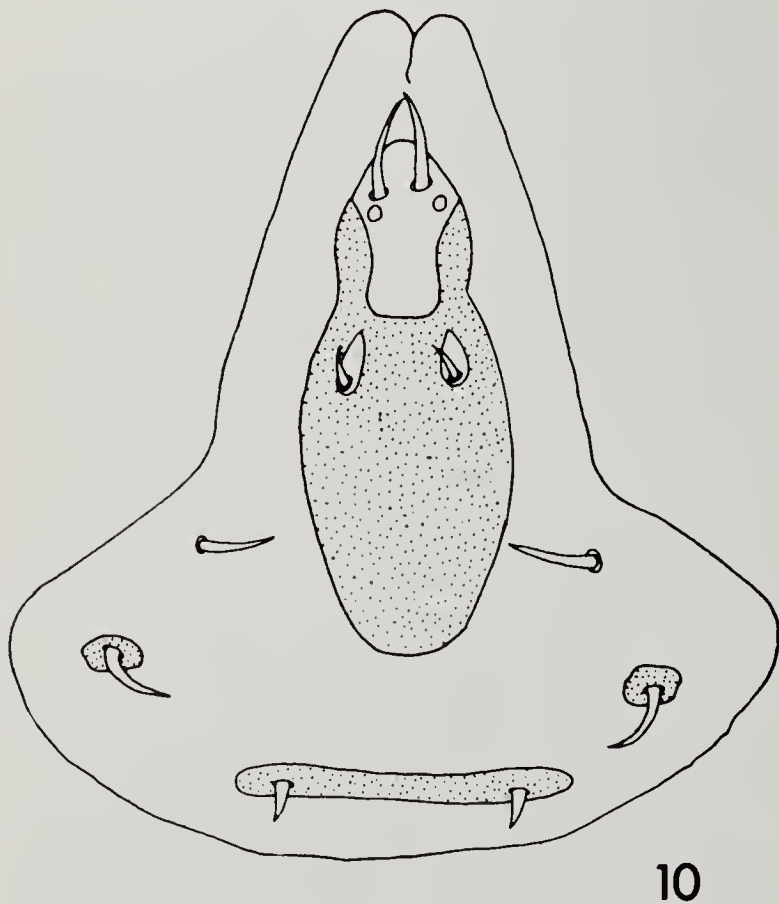
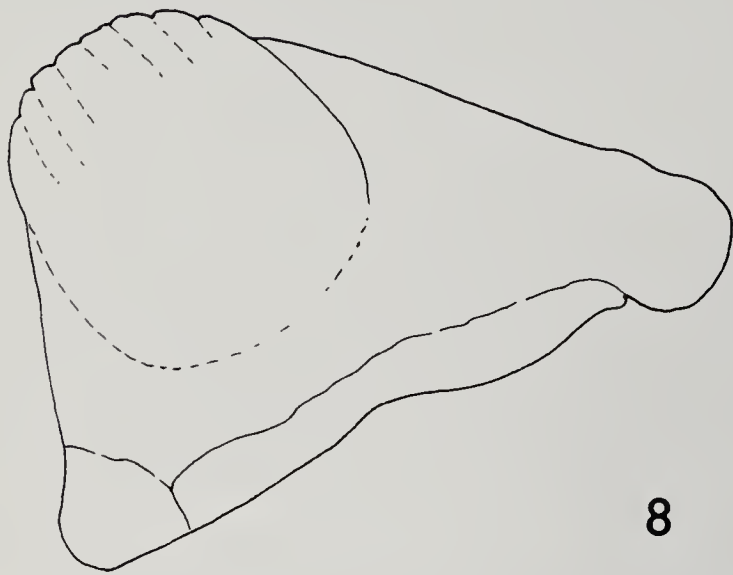
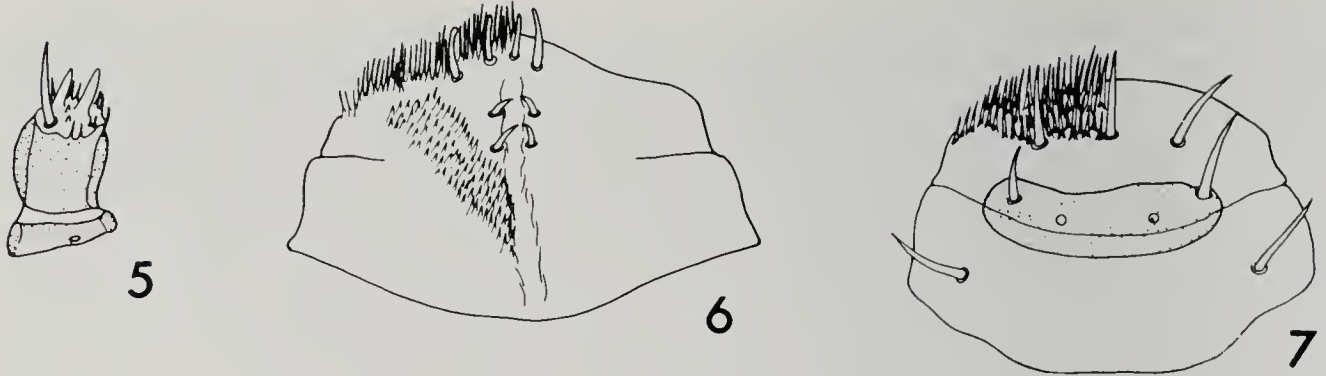
Fig. 3, Dorsal view of head capsule. Fig. 4, Ventral view of head capsule.

clypeolabral suture entire, overlapped by oval pigmented area, on labral side of suture are 2 centrally located sensory pores and 2 stout setae located antero-laterally of sensory pores; labrum bears distal arc of 5 peg-like setae, all subequal in length, 3 equidistantly spaced stout setae midway between arc of 5 setae and pigmented area, presence of 8 distal labral setae nearly obscured by dense setiferous mat extending over distal half of labrum. *Epipharynx*: (Fig. 15) evidence of transverse suture lacking, 2 pair of opposing, strongly decurved, short setae located antero-centrally; decurved setae bordered postero-laterally by bracket-shaped patches of dense, sharp sclerotized projections. *Mandible*: (Fig. 8) prognathous, monocondylic, cutting surface concave, smooth molar surface. *Maxilla*: (Fig. 16) with minute triangular cardo; sclerite of stipes with single ventro-laterally located seta, membranous area of stipes bearing 11 setae; sclerite of palpifer with seta and sensory pore located ventro-medially, membranous region of palpifer with 2 setae and sensory pore, 1 seta located laterad of palpus, other seta and sensory pore located ventro-medially near sclerite of palpifer, dorsal aspects of palpifer and mala covered by dense setiferous mat; palpus 1 segmented, bearing single dorsal seta, length of seta one-half as long as palpus, numerous chemo-sensory pegs of subequal length located distally; mala bearing 3-4 spatulate setae located antero-medially, 7 sharp, stout setae of varying lengths located near base of spatulate setae. *Labium*: (Fig. 17) submentum well developed, C-shaped, projecting laterally, bearing pair of short, sharp medially located setae, 2 pair of similar sized setae located laterally in membranous region between submentum and mentum; mentum with quadrate base and prong-like anterior projections, 2 setae in body of mentum isolated in membranous pockets; glossae fused, supporting pair of setae near ends of prong-like projections of mentum. *Legs*: (fig. 18) distance between legs increasing with each succeeding segment, directed antero-medially, 4 segmented, 2 small setae 1 base of distal segment, 1 near distal end of 3rd segment. *Spiracles*: (Fig. 19) oval, mesothoracic and 1st abdominal pairs twice as large as remaining pairs (Fig. 1), atrium with numerous sclerotized projections each appearing singly. Anus transverse, terminal.

*Material Examined*: 6 final instar larvae, Cohocton, New York, 19-VIII-1897, from peas, W. L. Noble, collector. Specimens provided by U.S. National Museum, Agricultural Research Division. Determined by association with reared adults.

#### *Bruchus rufimanus* Boheman

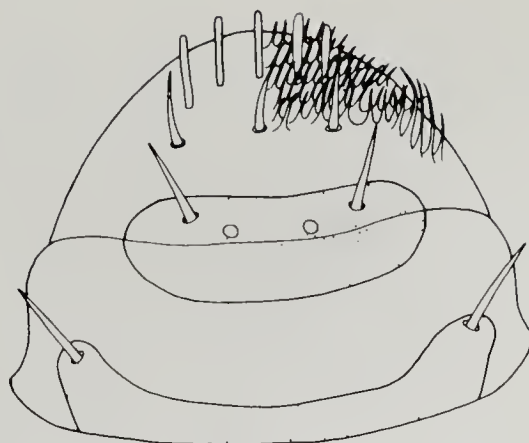
Characteristics of the final larval instar. *Body*: (Fig. 1) length 4-5.5 mm, C-shaped, robust, subcylindrical, each succeeding thoracic segment of greater diameter, 1st thru 3rd abdominal segments subequal in diameter with increasing length posteriorly, 4th thru 6th abdominal segments nearly subequal with slight posterior taper, pronounced taper exists with segments 7 thru 10, 10th segment button-like nearly concealed by segment 9. (The alternate body form seen in Fig. 2 was exhibited by two specimens. Its reliability is questionable and is probably due to movements or crowding during preservation.) Cuticle white to yellowish, without sclerotization, 2 vaguely yellowish pigmented areas on anter-dorsal aspects of prothorax. Setae nearly inconspicuous, restricted primarily to sternal some pleural regions, longest on thoracic sternites, sparse on all tergites restricted primarily to plical crests of larger abdominal segments. *Head*: (figs. 3 & 4) retracted (Fig. 1), oval, dorso-ventrally flattened, ventral surface (Fig. 4) occupied mostly by occipital foramen, light tan coloration, pigmentation concentrated near mouth-parts primarily on mandibles. One ocellus located near base of each antenna, situated along anterior arms of lyre-shaped epicranial suture, without pigment. *Antenna*: (Fig. 20) located at base of mandible (fig. 1); 2 segmented; basal segment flat, broad; apical segment nearly quadrate in appearance, two-thirds as wide as basal segment, distal end occupied by 2-3 chemo-sensory pegs and 1 large sensilla basiconicum, sclerite of distal segment terminating in fringe of sclerotized projections; distal segment bearing 2 setae, 1 subequal in length to distal segment located immediately outside fringe, 2nd seta 1/4 as long as distal segment located near apical end opposite larger seta. *Clypeolabrum*: (Fig. 21) lightly pigmented; proximal and distal borders biconvex; clypeolabral suture incomplete, with slight lateral vestiges; clypeal portion without pigmented area, supporting 2 well-developed laterally located setae; elongate, oval pigmented region overlapping clypeolabral border, 1 seta located near lateral extremes of pigmented area, 1 pair of sensory pores located mesad of setae; labrum bears distal arc of 4 peg-like setae, proximal to these is 2nd arc of 3-pointed setae of variable lengths; distal arc nearly concealed by dense mat of setiferous-like



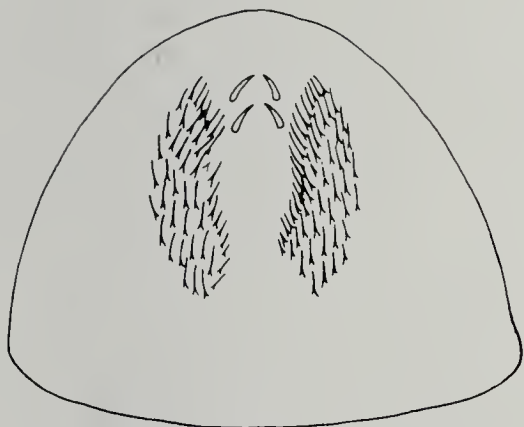
Figs. 5-12, Final larval instar of *Bruchus brachialis*: 5) antenna; 6) epipharynx; 7) clypeolabrum; 8) mandible; 9) maxilla; 10) labium; 11) leg; 12) spiracle.



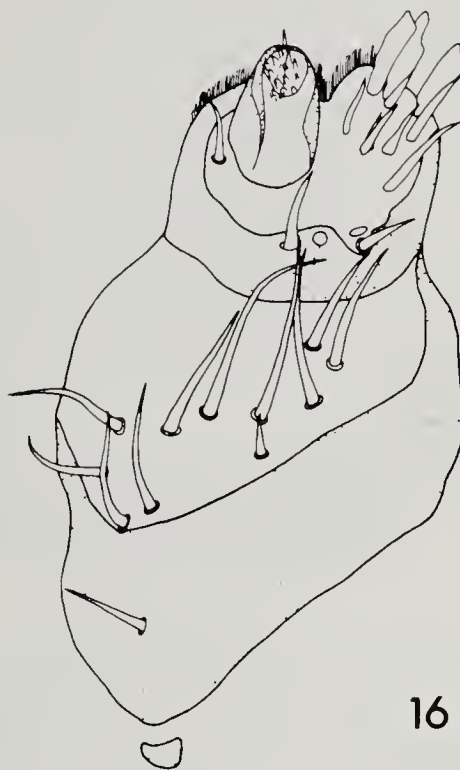
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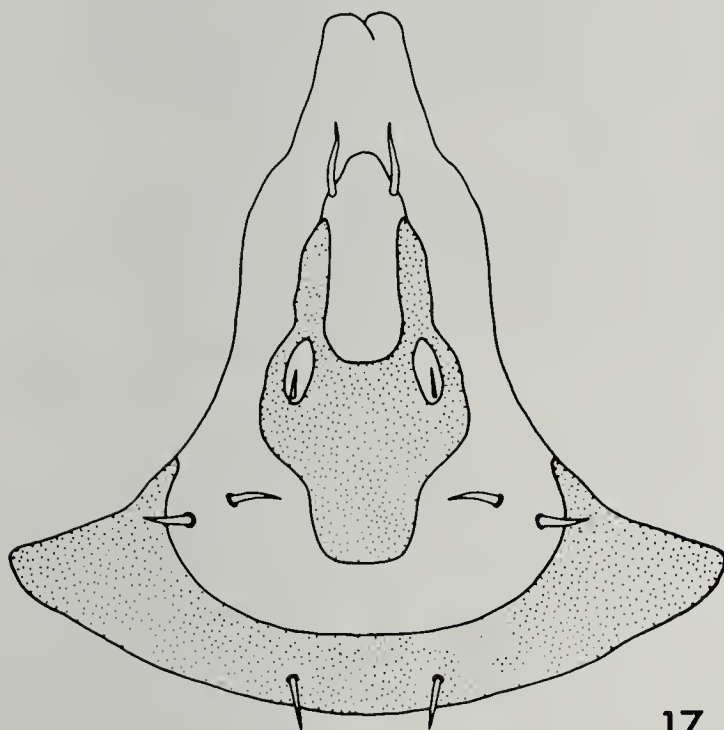
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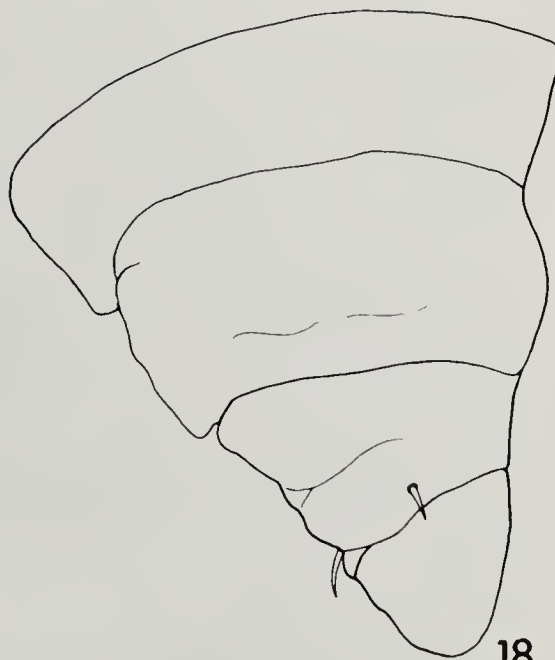
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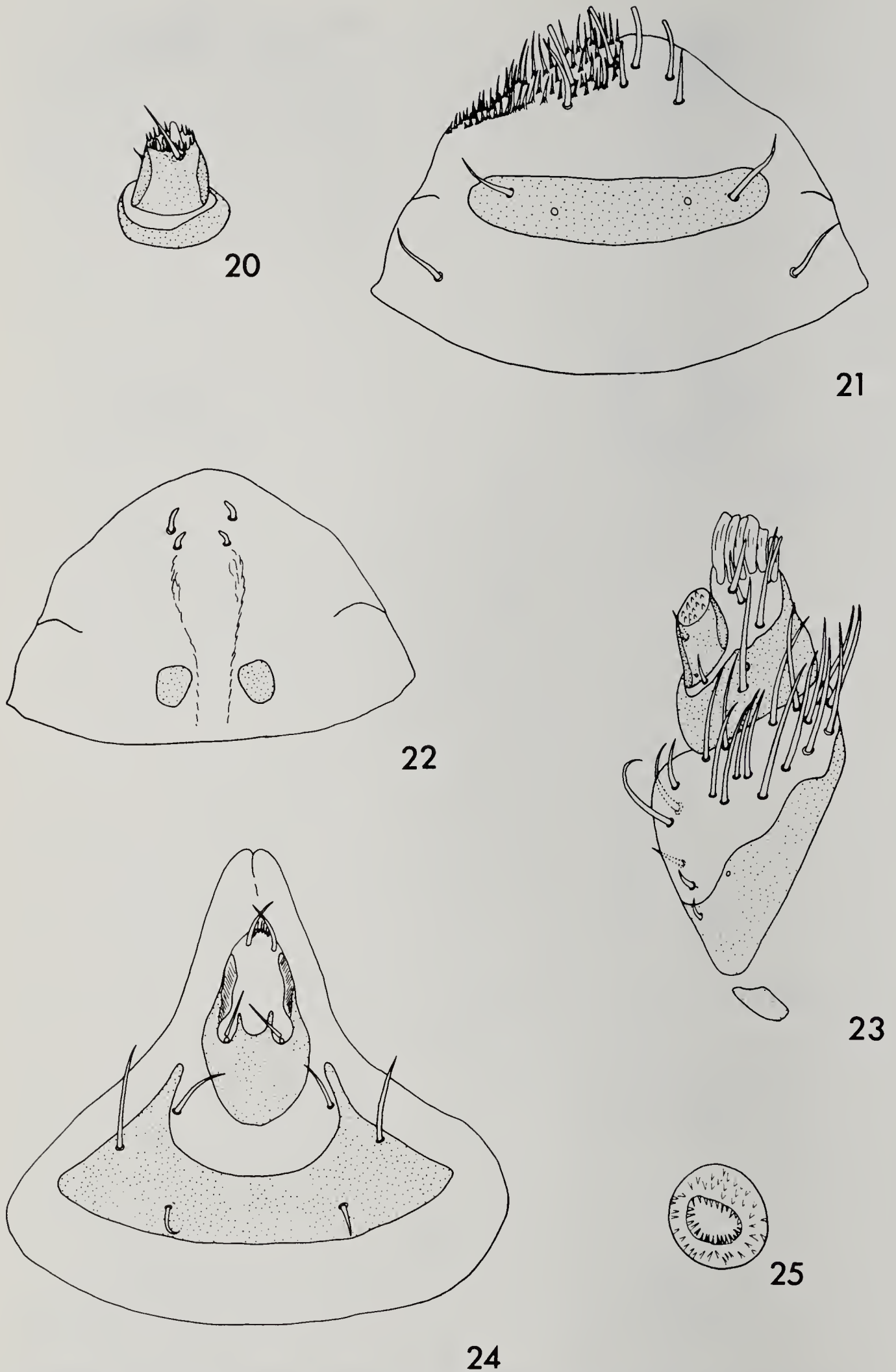


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Figs. 13-19, Final larval instar of *Bruchus pisorum*: 13) antenna; 14) clypeolabrum; 15) epipharynx; 16) maxilla; 17) labium; 18) leg; 19) spiracle.



Figs. 20-25, Final larval instar of *Bruchus rufimanus*: 20) antenna; 21) clypeolabrum; 22) epipharynx; 23) maxilla; 24) labium; 25) spiracle.



sclerotized projections, projections of varying lengths. *Epipharynx*: (Fig. 22) short lateral vestiges represent transverse suture; 2 small, circular, pigmented patches located proximally and laterad of median groove; median trough bordered by fine setae, trough flares apically; 2 pairs of opposing, decurved, short setae near distal end of trough. *Mandible*: (Fig. 8) prognathous; monocondylic; cutting surface concave; smooth molar surface. *Maxilla*: (Fig. 23) cardo minute with quadrate base and acuminate latero-distal end; stipes triangular, sclerite with undulating anterior border, small decurved seta and sensory pore embedded in ventral antero-lateral portion of sclerite, membranous region of stipes with 20 well developed setae of varying lengths; palpifer with single, elongate seta and sensory pore embedded in ventro-median aspects of sclerite, membranous region with 4 setae, 1 at ventral base of palpus, 3 between base of palpus and mala, of these 2 appear dorsad and near base of spatulate setae on mala; mala with 5-6 spatulate setae, 1 peg-like located lateral to ventral spatulate seta; palpus with single, short setae on dorso-medial area of sclerite, 1 latero-ventral sensory pore, numerous distal, conical sensillae of subequal lengths. *Labium*: (Fig. 24) triangular shaped; submentum well developed, anterior border C-shaped, sclerite with 2 latero-distal points, 4 setae, 2 short of proximo-medial location, 2 long, latero-distal in location, 2 setae of median length located near ends of C-shaped anterior border in membranous region between submentum and mentum; mentum with ovoid base, anterior arms appear twisted, pockets in mentum base partially enclosed, each pocket with seta and proximal sensory pore; glossae fused with 2 apical, decurved setae of median length, numerous, smaller setae, less than half their length anterior to base of decurved setae. *Legs*: (Fig. 18) distance between legs increasing with each succeeding segment, directed antero-medially, 4 segmented, 2 small setae 1 at base of distal segment, 1 near distal end of 3rd segment. *Spiracles*: (fig. 25) oval if body shape as in Fig. 1, round if body shape as in Fig. 2; atrium with numerous sclerotized projections of irregular arrangement. Anus transverse and terminal.

*Material Examined*: 3 final instar larvae, Tangier, Morocco, 3-IX-32, from seeds of the broad bean, collector unknown. Specimens provided by U.S. National Museum Agricultural Research Division. Determined by association with reared adults.

#### DISCUSSION

The 3 species described in this paper are rather easily distinguished by features of the antenna, clypeolabrum, epipharynx, and labium. The chaetotaxy, shape of the cardo, and features of the maxilla may be of intermediate value, whereas features of the legs and spiracles appear to be of little significance.

The antenna of *B. brachialis* (Fig. 5) is distinguished by the presence of 2 elongate sensilla basiconica located on the apical end of segment 2. Both sensilla are of equivalent size and are slightly more than 1/2 as long as the associated elongate seta. This species also lacks a complete circumscribing row of pointed asperities at the distal end of segment 2, a feature characteristic of *B. pisorum* and *B. rufimanus*. Both antennal segments of *B. pisorum* (Fig. 13) are subequal in width, whereas *B. rufimanus* (Fig. 20) has a broad, flat basal segment half again as wide as the distal segment. Both *B. pisorum* and *B. rufimanus* bear distally an elongate sensillum basiconicum and seta. However, in *B. pisorum* these are of subequal lengths and arise from contiguous bases, whereas the distal seta of *B. rufimanus* is located outside the encircling asperities and is approximately twice as long as the terminal sensillum.

The clypeolabrum of *B. pisorum* (Fig. 14) is distinguished by the crescentic pigmented region at the base of the clypeal plate. *B. pisorum* and *B. rufimanus* (Fig. 21) bear distally a double arc of blunt setae, a feature not observed in *B. brachialis* (fig. 7). There are 5 setae in the distal arc of *B. pisorum* and only 4 in *B. rufimanus*.

The epipharynx of each species is quite distinctive and is of considerable value in species identification. *B. brachialis* (Fig. 6) bears distally an arc of

decurved, blunt setae. A dense setiferous mat extends beyond the setal arc and conceals the distal edge of the epipharynx. *B. brachialis* and *B. pisorum* (Fig. 15) possess 2 patches of pointed asperities. Those of *B. brachialis* are arranged obliquely and present a V-appearance, whereas those of *B. pisorum* are crescent-shaped and present a ()-appearance. A trough like median depression exists along the longitudinal median axis of *B. brachialis*, where it is uniformly narrow, and *B. rufimanus* (Fig. 22), where it undergoes a distolateral expansion and does not pass between the 2 pair of decurved setae as it does in *B. brachialis*. The 2 semicircular, sclerotized, pigmented areas flanking the proximal portion of the median depression of *B. rufimanus* are distinctive.

The most useful traits of the maxilla are those associated with the cardo and the chaetotaxy of the stipes. The boomerang-shaped cardo of *B. brachialis* (Fig. 9) is significantly more developed than that of the other two species. The well-developed cardo is of particular value in distinguishing this species from *B. pisorum* (Fig. 16) since both bear approximately 11 setae on the membranous region of the stipes. Neither species resembles *B. rufimanus* (Fig. 23) in this respect since the latter possesses 20-21 stipeal setae. However, the sclerite of the stipes supports a seta near its base in both *B. pisorum* and *B. rufimanus* but not in *B. brachialis*. The number of setae associated with the spatulate forms on the mala may also represent a character of high priority; *B. brachialis* and *B. rufimanus* bear 2-4 setae whereas *B. pisorum* bears 6-8 setae.

The taxonomic significance of the labium compares with that of the epipharynx. The vestigial nature of the submentum of *B. brachialis* (Fig. 10) differentiates it from the other two species. *B. pisorum* (Fig. 17) is distinguished by the presence of 2 pairs of setae in the membranous region between the mentum and submentum. Furthermore, the submentum of *B. pisorum* is more extensive, spanning the full width of the labial base. *B. rufimanus* (Fig. 24) is distinguished by its well-developed submentum bearing 2 pairs of setae, and it lacks the isolated membranous islets within the mentum characteristic of the other two species. The presence of 3-5 small, erect setae (nearly concealed by the convergent, overlapping, larger pair) at the distal end of the mentum may also be useful in distinguishing the broad bean weevil.

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